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APR 16 1976

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Fertilizer Response of Alkali Sacaton and Fourwing Saltbush Grown on Coal Mine Spoil¹

Earl F. Aldon, H. W. Springfield, and David G. Scholl²

The response of two native species to nitrogen and phosphorus fertilizer was tested on New Mexico mine spoil.

Three levels and three times of application of N and P were tested in the greenhouse. Spoils were a composite sample from strip mining done in the Fruitland Formation. Results showed that adding N or P alone at any level had little effect on yield. Combined application of N and P, however, increased yield two to three times in both species. Yield responses differed between species depending on both relative amount of N or P in the mix and the time of application.

Keywords: *Atriplex canescens*, *Sporobolus airoides*, fertilizer response, coal mine spoil.

The need for reclamation on mined areas of the West has become acute with the recent acceleration in surface mining of coal. State and Federal laws demand mined areas be returned to a stable condition through topographic shaping and vegetation establishment. Hopefully, these lands can also be returned to productivity. Establishment of adapted plant species can enhance productivity by providing forage for domestic livestock, shelter and food for wildlife, and protection from wind and water erosion.

Alkali sacaton (*Sporobolus airoides*) and fourwing saltbush (*Atriplex canescens*), the two species tested here, are valuable forage plants in semiarid plant communities. They provide palatable forage for domestic livestock and retard erosion on alluvial flood plains. Methods of establishing these plants have been worked out for wildland conditions (Springfield

1970, Aldon 1974). In laboratory studies, soil amendments showed some promise in improving growth of these species on mine spoil materials (Aldon and Springfield 1973). The objective of this study was to determine the optimum time and rate of fertilizer application for the two species on New Mexico coal mine spoil.

Methods

Spoil materials were composite samples from two selected areas on the Navajo Mine, 20 miles southwest of Farmington, New Mexico. The spoils from the Fruitland Formation were less than 2 years old. Physical and chemical characteristics of the material are as follows:

Sand (percent)	22.7
Silt (percent)	24.4
Clay (percent)	52.9
Texture class	Clay
Sodium absorption ratio	40.1
Electrical conductivity of saturation extract (m mhos/cm)	8.0
Determined from saturation extract:	
pH	8.0
Na (ppm in soil)	1850
Ca (ppm in soil)	141
Mg (ppm in soil)	45
NO ₃ (ppm in soil)	68
P (ppm in soil)	8.5

¹The research reported here is a contribution of the SEAM program. SEAM, an acronym for Surface Environment and Mining, is a Forest Service program to research, develop, and apply technology that will help maintain a quality environment and other surface values while helping meet the Nation's mineral requirements. This work was conducted in cooperation with Utah International, Inc. who furnished study areas and materials.

²Principal Hydrologist, Range Scientist, and Soil Scientist, Rocky Mountain Forest and Range Experiment Station, located at Station's Research Work Unit at Albuquerque, in cooperation with University of New Mexico; Station's central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.

The spoil material was put in 1-liter plasticized round pots (10 cm in diameter by 12 cm tall). Each pot was filled with 1,200 g of the spoil material, which had been screened through a 1.3 cm mesh.

Fertilizer treatments included three levels of nitrogen (N_0 , N_1 , N_2) and phosphorus (P_0 , P_1 , P_2) in all combinations. Nitrogen was applied as ammonium sulfate (21-0-0) and phosphorus as treble superphosphate (0-45-0). Levels of application were as follows:

N_0 or P_0 = no fertilizer.

N_1 or P_1 (lower level) = 89.7 kg/ha (80 lbs/acre).

N_2 or P_2 (higher level) = 179.4 kg/ha (160 lbs/acre).

Fertilizers were applied at one of the following times:

T_1 = time of seeding (May 31).

T_2 = 1 month after seeding (July 1).

T_3 = 2 months after seeding (August 1).

Procedures for adding the fertilizer at the time of seeding were (1) 4 cm of spoil were removed from the pot; (2) the proper amount of fertilizer was mixed thoroughly with this 4 cm; then (3) the mixture was returned to the pot. For the other two times of application, the fertilizer was spread uniformly over the surface of the spoil.

Thirty seeds of one species were planted in each pot at the start of the experiment. Alkali sacaton seeds were harvested in 1969 at the Los Lunas Plant Materials Center (NM-184). Fourwing saltbush seeds were harvested in 1968 at the Los Lunas Plant Materials Center (NM-155).

Procedures for seeding varied slightly by species. For alkali sacaton, about 0.5 cm of spoil was removed from the pot, the surface was smoothed, seeds were uniformly distributed, and the spoil was returned as a covering. For fourwing saltbush, about 1.0 cm of spoil was removed to provide a deeper covering for the seeds.

For germination comparisons, seeds of both species were placed on moist blotters in petri dishes, which were put adjacent to the pots on benches in the greenhouse.

Moisture content of the pots was held approximately at field capacity for the duration of the experiment. Field capacity was arrived at by saturating 840 ml of spoil, allowing excess water to drain out for 24 hours, then determining the water still present by oven-drying. Three samples were used for these determinations. The average weight of water determined in this way was added to the pots at the start of the experiment. Gross weight of pots was checked periodically to maintain moisture near the desired level.

Temperatures recorded in the greenhouse during the 90 days ranged from 56° to 100°F (mean maximum 89.4°F; mean minimum 63.8°). Pots were completely randomized on the greenhouse benches. There were two replications of each fertilizer treatment.

Data were obtained on seedling emergence, seedling height at 15-day intervals, and oven-dry weight of shoots at the end of 90 days. Data were analyzed by analysis of variance and multiple range tests at the $P = 0.05$ level.

Results

Seedling Emergence

Emergence of fourwing saltbush and alkali sacaton seedlings were not affected by fertilizer treatment. Average emergence of saltbush was 25.6 percent compared to 76.2 percent for sacaton. These percentages may be compared to 37.7 percent for saltbush and 76.5 percent for sacaton in petri dishes.

Plant Height

Seedling heights were influenced by fertilizers to varying degrees. Date of application of fertilizer did not influence height of sacaton. Delaying application until 2 months after seeding resulted in shorter plants of saltbush. The highest level of P in combination with either level of N tended to produce the tallest plants of fourwing saltbush, whereas the highest level of N in combination with either level of P produced the tallest plants of alkali sacaton.

Yield

Plant yields were significantly affected by time of fertilizer application as well as by levels of N and P.

Time of fertilizer application was probably significant because the experiment was terminated before there was opportunity for the plants to fully respond to the fertilizer applied 2 months after seeding. Alkali sacaton apparently was able to utilize the N and P applied 30 days after seeding, whereas the fourwing saltbush appeared to respond more slowly to fertilizer.

Neither species yielded more when N or P was applied singly, regardless of level. There was a tendency, however, for saltbush yields to increase when more N was added in the absence of P. In general, adding N or P alone at either level had very little effect on yield (fig. 1).

Combining N and P significantly increased yield of both species. Alkali sacaton plants fertilized with N and P, for example, yielded 2½ to 4 times more than the unfertilized controls. Similarly, fourwing saltbush plants fertilized with N and P generally yielded 2 to 3 times more than unfertilized plants. The best response of alkali sacaton was obtained when N and P were applied at the high level 1 month after seeding. With saltbush, however, the higher levels of fertilizer did not result in much additional yield.

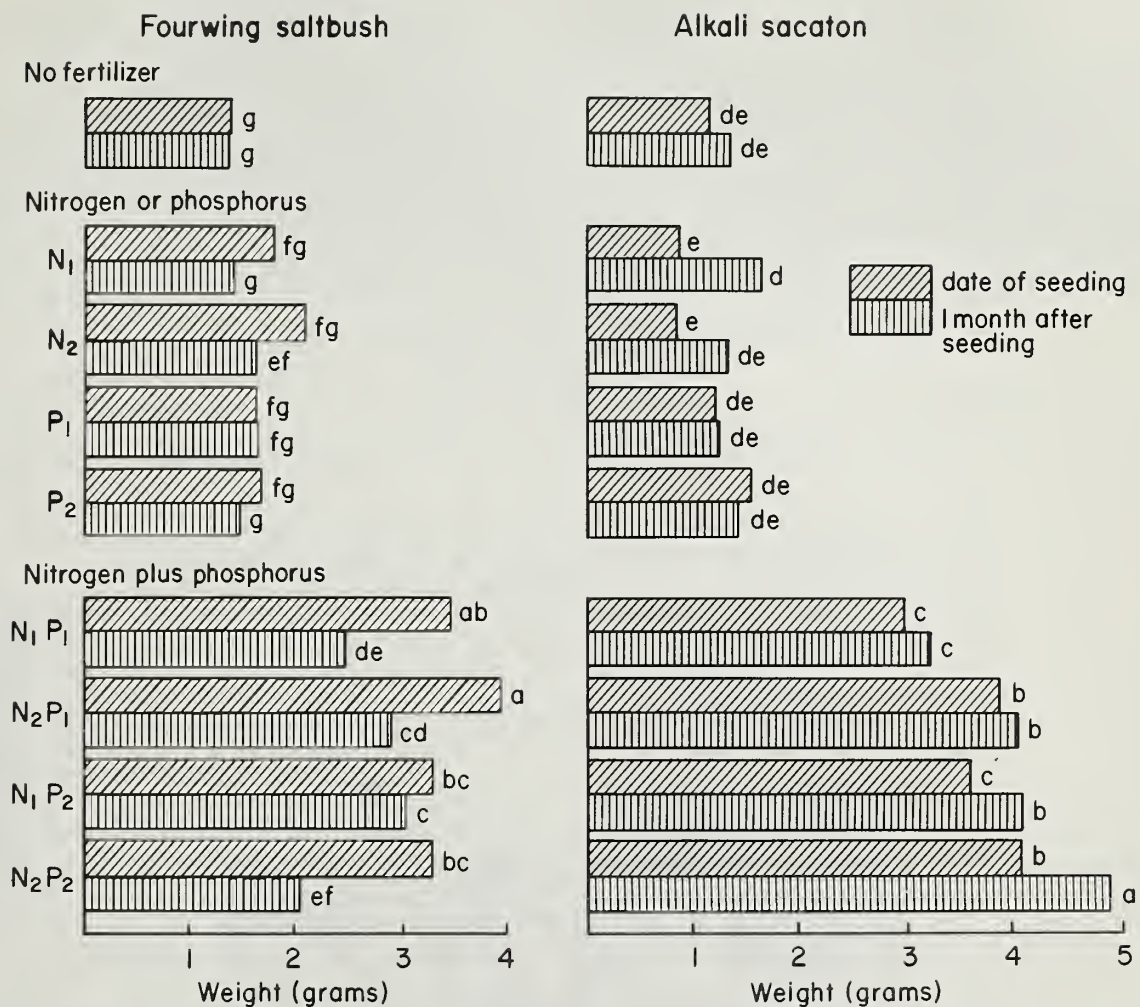


Figure 1.—Response of fourwing saltbush and alkali sacaton to N and P fertilization at two different times. Bars labeled with the same letter are not significantly different at the 0.05 level.

Saltbush seemed to be slower than sacaton in responding to fertilizer. Consequently, the highest yields of saltbush generally came from applying fertilizer at the time of seeding. Statistical comparisons indicate that when fertilizer was applied at the time of seeding, the N₁P₁ treatment was as effective as the N₂P₂ treatment for saltbush plants. Even when fertilizer was applied 30 days after seeding, the yield from N₁P₁ was as high as the yield from N₂P₂. These comparisons suggest the lower level of N and P is satisfactory for saltbush.

Conclusions

1. Seedling emergence was not affected by fertilizer treatment.
2. Effects of fertilizer on plant height generally was reflected in plant yield.

3. Neither species yielded more if either N or P was applied alone.

4. Combinations of N and P increased yields of both species two to three times.

5. Alkali sacaton yielded the most when N and P were applied 1 month after seeding at the higher level. Doubling the fertilizer level to obtain this additional yield, however, would probably be uneconomical.

6. The higher levels of fertilizer did not increase the yield of fourwing saltbush over what was obtained from the lower level.

7. Applying fertilizer at the time of seeding appeared best for saltbush, whereas delaying fertilizer application (especially P₂) until a month after seeding showed some advantages for sacaton.

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